

**Project Title:** Evaluation of Contaminant Bioaccumulation by Adult Idaho Salmon Species During Their Spawning Run Migration

**EPA Region:** 10

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**ORD Manager's Name and Signature:** Dale Hoff, EPA Office of Research and Development, Mid-Continent Ecology Division, Duluth, MN.

**Regional Science Liaison Contact:** Bruce Duncan, EPA Region 10, Seattle, WA.

**Anticipated Start Date:** April 1, 2017 (would prefer a start date of January 1, 2017 due to seasonality of fish collections)

**Anticipated Completion Date:** April 1, 2019

**Funding Requested:**

**Anticipated Funding Mechanism:** RARE grant and existing EPA Office of Water funding

**ORD Research Program:** *Include the ORD Research Program(s) that may have a link to the project or proposed goals. To the extent possible, identify the ORD Research Portfolio(s), topic area(s), and/or project(s) that align with this proposal.*

- Human Health Risk Assessment
- Safe and Sustainable Water Resources
- Sustainable and Healthy Communities

## PROJECT SUMMARY

**Statement of Problem:** U.S. Ambient Water Quality Criteria for human health (HHAWQC) set water concentrations for chemicals such that individuals consuming water and fish from U.S. waters do not incur unacceptable risk from this consumption. An important factor in developing HHAWQC is the fish consumption rate (FCR). As the FCR increases, HHAWQC become more stringent. This is particularly true for highly bioaccumulative chemicals.

A major policy question for the U.S. EPA is whether consumption of anadromous fish, in particular salmon, should be included in the FCR used to compute HHAWQC. Salmon may acquire contaminants via dietary or water exposures.

For highly bioaccumulative chemicals (i.e. chemicals which are highly fat soluble or lipophilic), such as PCBs, it is well known that most of the fish body burden of these chemicals comes from dietary rather than water exposure. For anadromous salmon in particular, nearly all of this body burden is acquired during feeding in marine waters. Guidance at the national level does not include salmon in the FCR, holding that salmon are feeding in ~~Since~~ non-coastal marine waters that are not under jurisdiction of the Clean Water Act (CWA). current U.S. EPA policy guidance at the national level has been to generally not include salmon in the FCR used to compute HHAWQC. This approach may not be valid for Region 10. Certain salmon species feed as adults in the near coastal waters of Oregon and Washington and other salmon are resident in Puget Sound, thus acquiring contaminants under CWA jurisdiction.

For less highly bioaccumulative organic contaminants, for example, chemicals with  $\log K_{OW} < 4$  such as endosulfan, lindane, and some chlorinated benzenes, water exposure, rather than diet, is likely the more significant contributor to contaminant body burdens. Adult salmon during inward migration to their natal spawning streams generally do not feed, making it unlikely dietary ingestion during the spawning run appreciably contributes to contaminant uptake. However, all returning salmonids are still exposed to and may bioconcentrate chemicals from water during their spawning run.

The general perception among toxicologists is that anadromous fish do not bioaccumulate appreciable quantities of organic contaminants during their spawning run. To our knowledge, this perception has not been empirically evaluated for the more water soluble organics with a  $\log K_{OW} < 4$ . We have already sponsored mathematical food web modeling (described in the research approach below) that indicates that some organic contaminants with  $\log K_{OW} < 4$  can bioconcentrate to levels in fish tissue that pose unacceptable risks to human consumers of fish, and that such contaminant concentrations are accumulated solely during spawning runs in the Columbia River basin. This is particularly true for Tribal consumers, whose fish consumption rates are often much higher than those of the general public.

The ultimate goal of this proposed work is to empirically evaluate ~~obtain empirical evidence regarding the bioconcentration-accumulation~~ of organic contaminants in salmon during their spawning run.

**Research Approach:** This research has two primary components:

1. Perform food web modeling to identify the potential for bioaccumulation of low  $\log K_{OW}$  organic contaminants in anadromous salmon to levels posing unacceptable human health risks solely during exposure to Columbia River watershed surface waters during their spawning run, and
2. Collect and analyze contaminant levels in tissues of returning salmon, to evaluate the predictions of the food web modeling regarding the potential for unacceptable risks to fish consumers solely from contaminants bioaccumulated during the spawning run of salmon.

We have already contracted with Dr. Frank Gobas of Simon Fraser University in Burnaby, British Columbia, Canada to perform the first component of our research. Using the widely used food web model that Dr. Gobas and his students have developed, Dr. Gobas has already performed food web modeling of Columbia River anadromous salmon during their spawning run from the mouth of the Columbia River to one of several rivers in Idaho. It is the results of Dr. Gobas' work for us that leads us

to believe there is a potential for anadromous salmon to bioconcentrate some organic contaminants, particularly semi-volatile organic compounds with  $\log K_{ow} < 4$ , to tissue concentrations posing unacceptable risks to some human consumers of fish. This is particularly true for Tribal fish consumers.

The second component of this work is to obtain empirical evidence from field collected adult salmon on their spawning run regarding the contaminant levels in their tissues. To date, most chemical analyses of returning salmon have focused on highly bioaccumulative chemicals such as PCBs and DDT. Based on the results of the already completed food web modeling, we are more concerned with less hydrophobic contaminants such as chlorinated benzenes, lindane and endosulfan. We have had preliminary contact with Dr. Dianne Barton of the Columbia River Intertribal Fish Commission to collaborate with EPA in this project.

#### **Anticipated Results and Regional Impact:**

**Anticipated Final Products:** We expect the final work product to consist of one or possibly two peer reviewed publications. The publication(s) will describe the mathematical food web modeling that led to the field collection of fish to confirm the food web model predictions, the results of the contaminant analyses of fish tissue, and the potential human health risks under recreational fisher and Tribal fish consumer exposure scenarios.

#### **PROPOSED PROJECT SCOPE**

**Background:** As discussed earlier, a major policy question for the U.S. EPA is whether consumption of anadromous fish, in particular salmon, should be included in the FCR used to compute HHAWQC. If salmon are acquiring a body burden of contaminants under CWA jurisdiction, then it would be appropriate to include them in the FCR used to set HHAWQC. Current approaches generally do not include anadromous fish in consumption estimates, because many of the more hydrophobic contaminants of human health concern such as PCBs have been shown to bioaccumulate primarily from dietary exposure while the fish are in marine waters outside the jurisdiction of the Clean Water Act. There is some evidence that adult salmon in the Pacific Northwest may be obtaining contaminants during feeding in marine environments under CWA jurisdiction. However, there has been little research done on the proposition. But if it were demonstrated that some contaminants bioconcentrate in adult anadromous salmon migrating back to spawn in fresh water and that these do accumulate to concentrations levels pose posing unacceptable human health risks to humans consuming salmon while anadromous fish are in fresh water during spawning runs. This latter point is an additional factor of importance to evaluate in determining whether a reason to include anadromous fish salmon in FCRs used to set HHAWQC. fish consumption rate estimates would be identified.

**Project History:** Very little empirical information is available from west coast U.S. river systems regarding concentrations of semi-volatile organic contaminants in returning salmonid species. Thus, there is no empirical basis to believe such contaminants are accumulated to concentrations posing unacceptable human health risks by returning salmon. However, the food web modeling of returning steelhead and Chinook salmon in the Columbia River basin by Dr. Gobas, performed during the fall of 2015, indicates the potential for some contaminants to be accumulated to levels posing unacceptable human health risks by returning salmon. The work proposed here is intended to evaluate the potential for returning salmon to accumulate semi-volatile organic chemicals with  $\log KOW < 4$  to levels posing unacceptable human health risks.

**Research Objectives:** The objective of this work is to identify whether organic contaminants with  $\log Kow < 4$  bioconcentrate during the returning spawning migration of salmon species and the human health risks posed by these to levels posing unacceptable human health risks during the returning spawning migration of salmon species. The general perception is that contaminants do not accumulate to levels posing unacceptable risks. However, the food web modeling we have already performed indicates that the commonly held perception may not be correct for some chemicals.

**Importance of Research to Region 10 and Nationally:** This research is important to EPA Region 10

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because of the current ongoing discussions regarding updates to Idaho's HHAWQC, including specifically the fish consumption rate FCR. This work may also be of relevance to HHAWQC generally for west coast states, including Alaska. A major consideration in developing an FCR for setting HHAWQC is included as part of the fish consumption rate discussions are discussions concerning which fish species to include in the consumption rate estimates. To date, salmon have not been included in the fish consumption rate estimates, because of the perception that returning salmon do not accumulate significant amounts of contaminants during the spawning run.

If it is found that significant bioconcentration into fish tissues occurs, to a level that poses human health risks to human consumers of fish, the findings may have national implications. This conclusion would provide support for including anadromous salmon in national fish consumption rates, because some of the contaminants posing risk would be accumulated during the spawning run. In addition to salmon species in the western United States, this potential risk could also be occurring in anadromous fish in other portions of the United States (e.g. east coast Atlantic salmon, striped bass).

**Research Approach:** We propose to collect returning adult salmon during their 2017 and 2018 spawning runs from the Columbia, Snake and Clearwater Rivers for chemical analysis. Species to be collected will be steelhead (*Oncorhynchus mykiss*) and Chinook salmon (*O. tshawytscha*). Due to the severely depleted numbers of sockeye salmon (*O. nerka*) returning to Idaho waters, we are not planning to collect any sockeye salmon during this study. Based on the timing of the spawning runs of steelhead and Chinook salmon, multiple collection events per year will be required. Steelhead have two seasons suitable for collection (January – April and September – December), while Chinook salmon have an April – September season.

Fish will be field collected from three general locations: mouth of the Columbia River (start of spawning run), Snake-Columbia River confluence (near midpoint of the longer spawning runs) and headwater spawning streams in the Snake and Clearwater River basins. Fish will be collected with the cooperation of fishery biologists with the Columbia River Inter-Tribal Fish Commission (CRITFC). Fish will be shipped to the analytical chemistry laboratory (ALS Environmental, Kelso, WA) for contaminant analysis. EPA Region 10 staff and the ORD PI will review and analyze the chemical data to determine if returning salmon have accumulated sufficient amounts of organic contaminants during their spawning run to pose unacceptable human health risks.

**Project Team's Roles and Responsibilities:** *Describe the role of each project team member (ORD PI, PO, RSL, Regional Staff, contractors, others) in the planning and execution of each phase of the project.*

#### **Research Results, Products, and Communication Plan:**

We anticipate peer-reviewed journal publication(s) on the food web modeling predictions of contaminant uptake by salmon on their spawning run, the results of the empirically measured contaminant tissue concentrations of the organic contaminants to be measured, and the potential for human health risks to fish consumers from the contaminants accumulated in salmon during their spawning run.

We further anticipate presentation of the results at one or more professional society conferences.

We anticipate using the results of this study to identify potential risks to human consumers of Columbia River anadromous salmon from contaminants accumulated during the spawning run of the fish.

Findings from this research will be shared with state and Tribal environmental protection agencies, natural resource agencies, and public health agencies.

The peer review publications are collaborative products with ORD-Duluth, Region 10 and the analytical chemistry laboratory, and provided to EPA according to any specialized terms and conditions of any contracts, subcontracts or interagency agreements, assuming this work is funded.

**Proposed Budget:** *Projects can be proposed that require from one to three years of funding. **For multi-year projects, annual products or deliverables are required.** Describe key schedule actions or milestones and how they may impact the Research Approach described above. Briefly describe in qualitative and quantitative terms the resources necessary (e.g., the level of technical staff involvement (ORD, regional, and other partners), materials necessary, anticipated publications including associated peer review). Annual budget totals are required for funding consideration. The funds may be used for contracts, cooperative and interagency agreements, or grants; however funds may not be used to procure equipment, or travel or training for any personnel.*

*ORD proposal team members can consult their Extramural Management Specialist for more details on available mechanisms for the specific project.*

**Project Management:** A Quality Assurance Project Plan (QAPP) documents the planning, implementation, and assessment procedures for a particular project, as well as any specific quality assurance and quality control activities. It integrates all the technical and quality aspects of the project in order to provide a "blueprint" for obtaining the type and quality of environmental data and information needed for a specific decision or use. All work performed or funded by EPA that involves the acquisition of environmental data must have an approved Quality Assurance Project Plan. The Quality Assurance Plan shall follow the U.S. Environmental Protection Agency guidelines (see EPA QA webpage, <http://www.epa.gov/quality/qapps.html>). This shall be prepared within the first 90 days of the award of the funding. The recipient must provide acceptable quality assurance and quality control documentation to the EPA Project Officer and if the EPA Project Officer provides review comments, the recipient must revise the QAPP accordingly.

The EPA project officer (Lawrence Burkhard, MED-Duluth) in consultation with the quality assurance manager (QAM; to be identified, we have used Barbara Sheedy, MED-Duluth on previous Regional Methods projects) recognize that analytical chemistry laboratory performing the fish tissue analyses will take the lead for the QA.

Specific standard operating procedures (SOPs) shall be developed and maintained for changes for the projects. These SOPs and detailed study plans and reports will be essential to understand and assist in performing experiments consistently following good scientific practices.

Historically, previous RARE and RM projects between EPA Region 10 and MED-Duluth have required delivery to EPA of quarterly progress reports from contractors, technical team conference calls and correspondence as needed to ensure the work is on schedule. According to Bruce Duncan, the EPA Region 10 liaison with EPA's Office of Research and Development, the format we have previously used for quarterly progress reports has been well received by ORD reviewers and laboratory directors. For multi-year projects, we have performed an annual review which determines whether EPA funding is recommended to continue into the second year of the work. We intend to continue these project management approaches in this work.